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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/780,863	02/19/2004	Soon Hyung Hong	2236.0010000/JUK/SMW	1952
26111 7590 08/16/2007 STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C. 1100 NEW YORK AVENUE, N.W. WASHINGTON, DC 20005			EXAMINER LAZORCIK, JASON L	
			ART UNIT 1731	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/780,863

Applicant(s)

HONG ET AL.

Examiner

Jason L. Lazorcik

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 June 2007.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-9 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 6/4/2007.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____.

Continued Examination Under 37 CFR 1.114

The request for a continued prosecution application (CPA) under 37 CFR 1.53(d) filed on [1] is acknowledged. 37 CFR 1.53(d)(1) was amended to provide that the CPA must be for a design patent and the prior application of the CPA must be a design application that is complete as defined by 37 CFR 1.51(b). See *Elimination of Continued Prosecution Application Practice as to Utility and Plant Patent Applications*, final rule, 68 Fed. Reg. 32376 (May 30, 2003), 1271 Off. Gaz. Pat. Office 143 (June 24, 2003). Since a CPA of this application is not permitted under 37 CFR 1.53(d)(1), the improper request for a CPA is being treated as a request for continued examination of this application under 37 CFR 1.114.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang et al. (J. Mater. Chem., 2001, 11, 1722-1725) in view of Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86).

Briefly, Hwang teaches a process of forming a carbon nanotube reinforced ceramic nanocomposite. As indicated by Applicant in the reply to Office Action dated November 2, 2006, the Hwang reference teaches sonication of the CNT solution for 10 minutes but it fails to explicitly provide for an extended sonication period of between 2 and 10 hours. However, Hwang clearly indicates that a stable and homogeneous suspension is critical to the quality of the product derived from the disclosed process, and that said suspension is achieved through the sonication step.

Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86) teaches the relationship between sonication time and CNT dispersion in aqueous solution for time periods up to approximately 5 hours. With specific attention to the instant reference Figure 2, Smalley tracks the intensity of a spectral feature indicative of dispersion quality as a function of time under continual sonication. The reference teaches that dispersion quality increases at least through the first four hours of sonication. It is the Examiners position that optimization of the sonication time was a recognized result effective variable of the dispersion quality at the time of the invention and that said time period would have been optimized through routine experimentation by one of ordinary skill in the art.

More specifically, it would have been obvious to one of ordinary skill in the art at the time of the invention to sonicate the CNT dispersion for a time period up to at least 5 hours in an effort to provide a high quality dispersion of CNTs. A high quality dispersion would have been a routine goal for one of ordinary skill seeking to optimize the uniformity of the resultant ceramic composite, and a sonication period between 2 to 10 hours is a minor and obvious extension over the prior art.

Therefore as presented in the prior Office Action regarding Claim 1, the instant reference teaches:

1. Adding carbon nanotubes (CNTs) to an aqueous solution of cetyltrimethylammonium bromide which is read as dispersing carbon nanotubes in a dispersion medium (Pg. 1722, Column 1, Lines 38-40)
2. Sonicating the solution or "dispersion" from (1) above (Pg. 1722, Column 1, Lines 40)
3. Adding sodium silicate and sodium aluminate to the sonicated solution from (2) above which is understood as dispersing a water-soluble salt in the sonicated dispersion. (Pg. 1722, Column 1, Lines 42-44)
4. Sonicating the solution or "dispersion" from (3) above (Pg. 1722, Column 1, Lines 44)
5. Placing the solution into an autoclave and heating at $\sim 110^{\circ}\text{C}$ to form a yellowish silicate powder followed by calcinations in air at 400°C to oxidatively remove surfactant molecules (Pg. 1722, Column 2, Lines 2-3).

This disclosure is read in the immediate claim as drying and calcinating the sonicated dispersion of (4) where the water soluble salt or sodium silicate forms a ceramic matrix of SiO₂ post-calcination. Steps 1-5 yield a ceramic nanocomposite powder referred to by the authors as SiO₂-CNT rods wherein the CNTs are homogeneously encapsulated by or "dispersed in" a SiO₂ ceramic matrix (Pg. 1724, Column 1, Lines 11-12).

6. The SiO₂-CNT rods from (5) are mixed with SiO₂ powder and pressed into a disc followed by calcination or "further drying" in air at 400°C and calcination in an N₂ atmosphere at 1050°C to form a final composite disc.

Claim 2 is obvious in the rejection of Claim 1 above wherein it was set forth that the CNT dispersion is an aqueous solution.

Claim 3 is obvious in light of the rejection of Claim 1 wherein sodium silicate and sodium aluminate are understood to be metal-based salts of the metals Silicon and Aluminum, respectively, and at least the sodium silicate is capable of being formed into a SiO₂ ceramic matrix prior to calcination.

Claim 4 is obvious in light of the rejection of Claim 1 wherein a ceramic matrix of SiO₂ is from the group including silicon oxides.

Claim 5 is obvious in light of the rejection of Claim 3 and the rejection of Claim 1 wherein a ceramic matrix of SiO₂ is from the group including silicon oxides.

Claim 6 is obvious in light of the rejection of Claim 1 above wherein the claimed drying temperature range of 80 to 100°C is understood to be encompassed by ~110°C or "approximately" 110°C.

Alternately if it is deemed that "approximately" 110°C fails to read upon the disclosed temperature range, it would be obvious to one of ordinary skill in the art, seeking to dry a dispersion, to perform said drying step within a temperature range suitable for evaporating the dispersion medium. In the immediate case wherein said dispersant is water with a normal boiling point of 100°C, drying said dispersant at approximately 110°C would obviously encompass drying the dispersant in the temperature range of 80°C to 100°C since the latter range would yield materially equivalent drying effect.

Regarding Claim 7, Hwang indicates that "the silicate powder" described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. Although the instant reference does not explicitly teach the calcinations in the temperature range of 300 to 350°C as claimed, it is the examiners position that one of ordinary skill in the art at the time of the invention would be fully capable of determining the appropriate calcination temperature for a given ceramic matrix material.

While the Examiner acknowledges that the prior art range does not explicitly overlap the claimed range, the prior art calcining temperature of 400°C would be recognized by one of ordinary skill as so near the prior art temperature range as to be patentably indistinct therefrom. More specifically, one of ordinary skill in the art would have found ample motivation to explore lower calcining temperatures in an effort to

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reduce processing costs associated with manufacturing the ceramic composite material. Therefore absent any compelling and unexpected results showing to the contrary, claimed calcining temperature range of 300-350°C is held as a merely obvious extension over the prior art teachings.

With respect to Claim 9, the claim requires a calcinations temperature of 400°C or lower. Hwang indicates that "the silicate powder" described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. As such the Hwang process reads on the broad limitation of the claim which requires a calcination temperature of 400°C or lower. Further, where no distinction is drawn between the process of drying and the process of calcination, it is understood that the act of heating the silicate powder to the calcination temperature inherently requires traversing the claimed temperature range of 300 to 350°C. Since the primary solvent utilized by Hwang is water as indicated above, with a normal boiling point of 100°C, the act of heating the silicate powder through the temperature range of 300 to 350°C is understood to "further dry" said ceramic matrix.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang (J. Mater. Chem., 2001, 11, 1722-1725) as applied to Claim 1 above and in further view of Chang (6,420,293).

Hwang teaches that the SiO₂-CNT powder is to be calcinated in an N₂ atmosphere at 1050°C which falls within the claimed temperature range of 400-1700°C. Hwang fails to explicitly set forth that the calcination of the ceramic matrix, requiring a

calcination temperature of 400°C or higher as indicated above, should be performed under a high vacuum as claimed. Chang teaches that "heating of carbon nanotube materials at elevated temperatures in an oxidizing environment typically results in chemical changes in the surface of the particles (Column 3, Lines 51-54) and specifically that "heating in air at 640°C results in the formation of carboxyl and carbonyl groups at the particle surface" (Column 3, Lines 57-59). Both the N₂ atmosphere and a high vacuum environment are commonly utilized and well appreciated in the art as non-oxidizing environments. Processing under a high vacuum would be an obvious alternative for the nitrogen atmosphere since the Hwang process utilizes calcination temperatures of 1050°C and damage to the CNTs occurs at temperatures in excess of 640°C under oxidative environments as indicated by Chang. Therefore it would be obvious to one of ordinary skill in the art seeking to minimize said oxidative damage to substitute a high vacuum environment for the nitrogen atmosphere in the Hwang process since both nitrogen and high vacuum provide the requisite non-oxidative environments.

Response to Arguments

Applicant's arguments filed June 4, 2007 have been fully considered but they are not persuasive.

Applicant argues that Claim 1 requires the carbon nanotubes to be homogeneously dispersed in the ceramic matrix and that Hwang does not teach such a

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homogeneous dispersion in the disclosed composite. The key to Applicants argument lies in the definition and construction of the term "homogeneous" and specifically whether the prior art structure is properly interpreted as being homogeneous in nature. An examination of several dictionary references reveal the common definition of homogeneous as referring to a material which is "Uniform in structure or composition throughout" (*Dictionary.com Unabridged (v 1.1)* and *The American Heritage® Dictionary of the English Language, Fourth Edition*. Both references Retrieved August 15, 2007, from Dictionary.com website: <http://dictionary.reference.com/browse/homogeneous>).

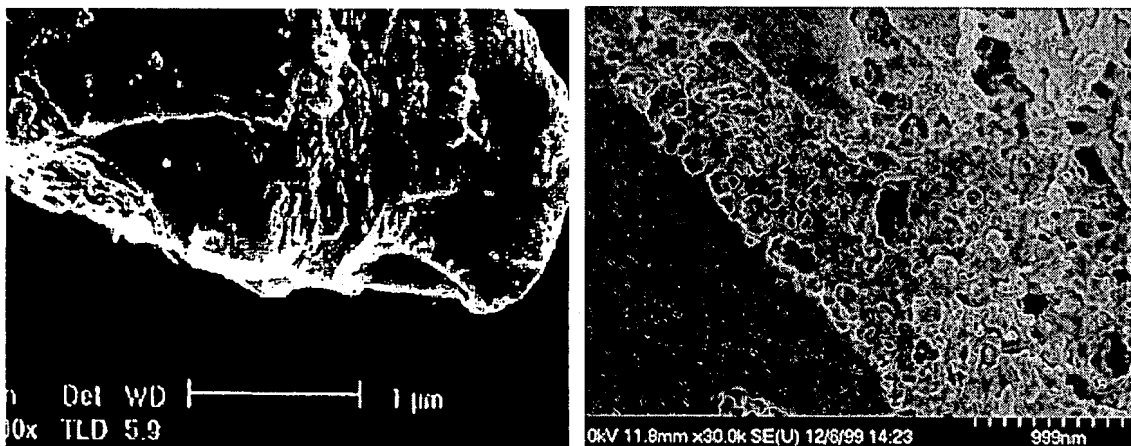
Applicant argues that the formation of micro-rods in the instant reference figure 1 evidence the fact that the carbon nanotubes are not homogeneously dispersed within the rod. Applicant further points to the Hwang reference (page 1723, column 2, line to page 1724, column 1, line 14) as further evidence that the prior art structures are not homogeneous. In this passage, Hwang indicates that some CNT's observed in a transmission electron microscope (TEM) image of figure 3(b) display a "roughly parallel" arrangement. From these reference excerpts, Applicant concludes that the prior art micro-rod structures do not display a "homogeneous" dispersion of CNT in the silicate matrix.

On this point, the Examiner strongly disagrees.

The stated tendency for the nanotubes to "roughly" align on the sub-micrometer or nanometer scale as indicated in the Hwang reference does not imply that the nanotubes are not homogeneously distributed through the matrix. Furthermore, the assembly of nanotubes and matrix material into macro-scale rod structures provides no

definitive restriction upon the uniformity of the constituent materials. Restated, a tendency of the CNT's to "roughly" align into self-assembled, hierarchical structures does not imply that the carbon nanotubes are not uniformly and/or randomly distributed through the entirety of the matrix.

This fact is clearly supported in the instant reference figures 3a and 3b which display high magnification electron micrographs of the resulting composite material depicted in the lower magnification micrograph of figure 1. In direct contrast to Applicants allegations, a close inspection of both of the fig 3 micrographs yields no conclusive evidence to support Applicants position that the CNT's are not evenly or uniformly distributed throughout the entirety of the matrix material. Further, a direct comparison between the scanning electron micrograph presented by Applicant and that of the prior art Fig 3(a) reveals a strikingly similar morphology between the two materials when viewed on the same magnification scale.



Applicant next argues that the Smalley reference is has been inappropriately combined with the Hwang teachings in that Smalley actually teaches away from the extended sonication period of 2-10 hours as presently claimed.

As set forth in the previous Office Action dated January 3, 2007 and in the Advisory Action dated April 12, 2007, Figure 2 in the Smalley reference (see caption) teaches "Fluorescence intensity as a function of sonication process time". Examiner does not dispute that aliquots of surfactant are added over the course of the sonication timeframe nor that fluorescence intensity "saturates" between aliquot additions. Although surfactant concentration and sonication time may provide a synergistic effect upon the suspension quality, the figure 2 plot undeniably teaches that fluorescence intensity increases at least in part as a function of sonication process time.

Where Applicant argues that Smalley teaches away from sonicating for between 2 to 10 hours, Examiner notes that Smalley teaches a combined process of surfactant addition with a simultaneous, positive step of sonication. Smalley does NOT simply teach the addition of a surfactant followed by, for instance, soaking or stirring the solution. To reiterate, it is the Examiners position that sonication is central to the results obtained by Smalley and therefore one of ordinary skill in the art provided with the Smalley teachings would find ample motivation to seek extended sonication times (e.g. between 2 to 10 hours) in order to achieve an enhanced nanotube suspension quality.

Further, where Applicant argues that Smalley's mathematical model is not a function of sonication time, Examiner strongly disagrees. Although this particular argument is deemed immaterial to the fundamental findings in the Smalley reference taken as a whole, Smalley's formula is a clearly and unambiguously a representation of the RATE OF CHANGE of concentration with respect to time for the nanotube concentration. The model is a mathematical representation of the results obtained by Smalley and Smalley utilized sonification of the solution to disperse the nanotubes. Therefore, the rate of change term in the instant formula is inherently a function in time and more importantly it is implicitly a function of sonification time.

Finally, Applicant alleges that the Examiner has not provided "an explicit analysis or reasoning as to why the references would be combined by a person of ordinary skill in the art". Again, Examiner strongly disagrees. As set forth in the previous Office Action,

"..., Hwang clearly indicates that a stable and homogeneous suspension is critical to the quality of the product derived from the disclosed process, and that said suspension is achieved through the sonication step. It would have been obvious to one of ordinary skill in the art at the time of the invention to optimize the sonication period in order to achieve a homogeneous dispersion of CNTs."

Continuing along the same line of reasoning in the Action,

"The reference teaches that dispersion quality increases at least through the first four hours of sonication. It is the Examiners position that optimization of the sonication time was a recognized result effective variable of the dispersion quality at the time of the invention and that said time period would have been optimized through routine experimentation by one of ordinary skill in the art."

A review of the prior Official correspondence clearly shows that an explicit rationale for combining the Smalley teachings with the process disclosed by Hwang was in fact provided. Further, Applicant has provided no convincing arguments to counter said combination.

Finally, Applicant is advised that the recent Supreme Court Decision in *KSR International Co. v. Teleflex Inc.* forecloses the argument that a specific teaching, suggestion, or motivation is required to support a finding of obviousness. See the recent Board decision *Ex parte Smith*, --USPQ2d--, slip op. at 20, (Bd. Pat. App. & Interf. June 25, 2007) (Citing *KSR*, 82 USPQ2d at 1396)

Conclusion


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason L. Lazorcik whose telephone number is (571) 272-2217. The examiner can normally be reached on Monday through Friday 8:30 am to 5:00pm.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven Griffin can be reached on (571) 272-1189. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JLL



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